

# Overview of Mobile Source Research and Modeling Efforts

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**Charles O. Mann**

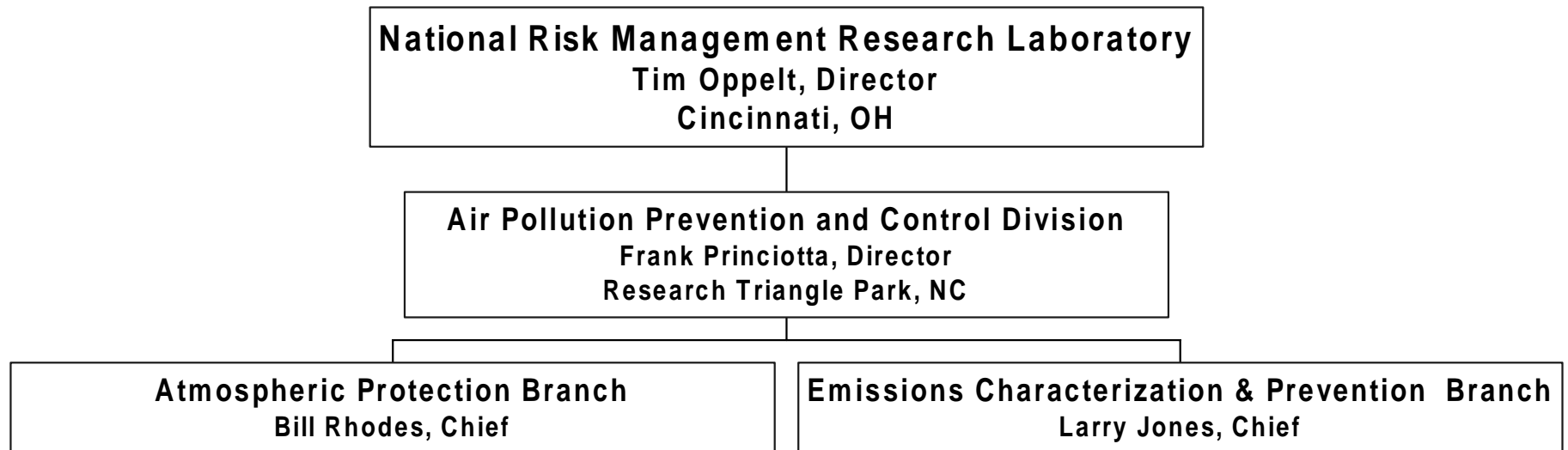
**Air Pollution Prevention and Control Division  
National Risk Management Research Laboratory  
Office of Research and Development  
Research Triangle Park, NC**

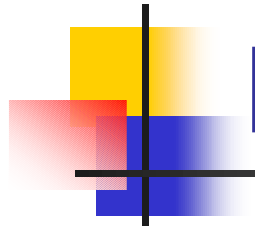
**Mobile Sources Technical Review Subcommittee  
Clean Air Act Advisory Committee  
Arlington, VA  
April 18, 2001**



# Partial Organization Chart for NRMRL

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# Mobile Source Research Areas

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- ✓ Emissions model application and development
- ✓ On-road vehicle emissions characterization
- ✓ Source/emissions technology assessments
- ✓ Source/emissions control technology verification



# Background/History

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- ✓ National Acid Precipitation Assessment Program emissions inventories (1980's)
- ✓ North American Research Strategy for Tropospheric Ozone (NARSTO)
  - ✓ **Initial emphasis on ozone precursor pollutants, later expanded to include particulate matter**
  - ✓ **Biogenics emissions research**
  - ✓ **Mobile sources emissions research**
- ✓ Cooperative agreement with Georgia Tech for mobile emissions research started in early 1990's



# Mobile Source Modeling Research Goals

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- ✓ Develop better “real world” estimates of highway vehicle emissions
- ✓ Reduce uncertainty of emissions estimates
- ✓ Contribute knowledge of activity vs. emissions relationships to other models
- ✓ Develop research model capability for assessing emissions control & policy issues



# Support of ORD Strategic Goals

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- ✓ Improve approaches for managing risks
- ✓ Characterize sources of ozone precursors, particulate matter, and air toxics
- ✓ Develop advanced air quality simulation models to relate sources, emissions, & receptors
- ✓ Integrate information to provide sound scientific base and technical support for Agency policies



# Modeling Research Components & Participants

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- ✓ Atlanta mobile model development
  - ✓ GIT lead w/ APPCD collaboration
- ✓ RTP mobile model development
  - ✓ APPCD in-house team w/ GIT collaboration
  - ✓ NC Department of Transportation and NC local planning agency contribution
- ✓ Heavy-duty diesel emissions research
  - ✓ B. Harris will describe in next presentation



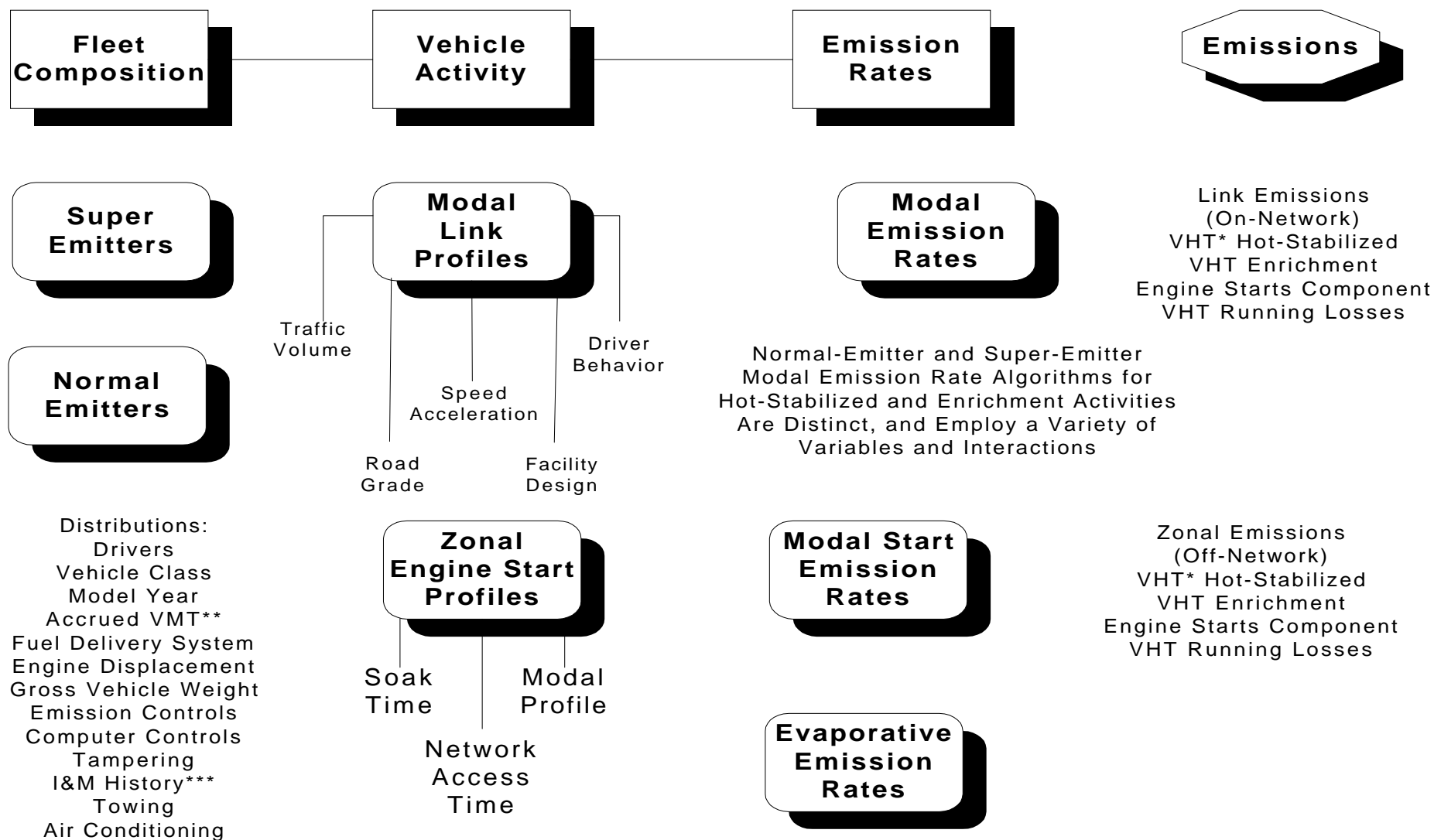
# MEASURE

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- ✓ Mobile Emissions Assessment System for Urban and Regional Evaluation
- ✓ Geographic Information System (GIS) modeling framework
- ✓ Modal modeling approach
- ✓ Desired characteristics:
  - ✓ **Affordable**
  - ✓ **Accurate**
  - ✓ **Stated confidence level**
  - ✓ **Validation is possible**
  - ✓ **Consider new fuels and technologies**
  - ✓ **Available in 5 to 10 years**



# MEASURE Conceptual View

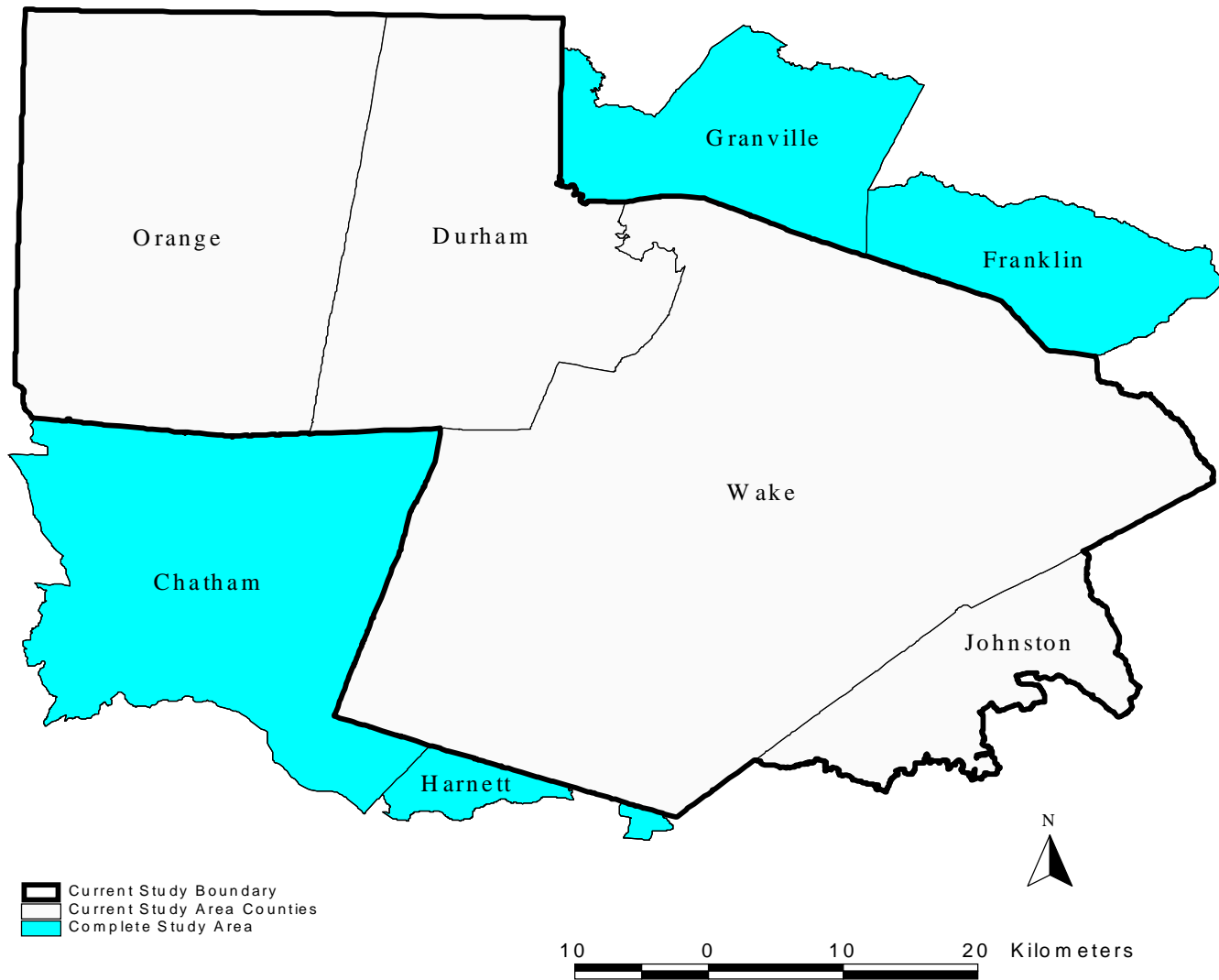


(\*) VHT = Vehicle Hours Traveled

(\*\*) VMT = Vehicle Miles Traveled

(\*\*\*) I&M = Inspection & Maintenance

# RTP Study Area





# MEASURE Modules

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- √ Modal emissions modules for carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>), and hydrocarbons (HC)
  - √ Engine starts for light duty gasoline vehicles (LDGV) by start zone
  - √ Hot stabilized emissions for major roads on link basis
    - √ **Aggregate modal module for LDGV**
    - √ **Power demand module for LDGV and light duty gasoline trucks (LDGT1, LDGT2)**
  - √ Hot stabilized emissions for minor roads on zonal basis



# MEASURE Modules

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- √ Non-modal modules
  - √ Evaporative module for HC for all vehicle classes
    - √ Based on MOBILE5b
  - √ Particulate module for  $PM_{10}$  and  $PM_{2.5}$  for all vehicle classes
    - √ Based on PART5 for exhaust, brake, tire wear and on AP-42 for fugitive dust



# MEASURE-RTP Future Plans

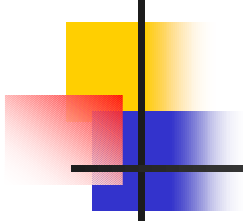
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- ✓ MOBILE6 update and integrated MOBILE-MEASURE development
- ✓ Coordination with OTAQ New Generation Model Working Group
- ✓ Potential research and development:
  - ✓ **On-road emissions module for commercial and heavy-duty trucks**
  - ✓ **Modeling of particulate and air toxic emissions**

# Light-Duty Vehicle Emissions Characterization

- v 1993 Chevrolet Lumina test vehicle





# Light-Duty Vehicle

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- ✓ On-board analyzers for measurement of tailpipe gaseous emissions ( $\text{CO}$ ,  $\text{CO}_2$ ,  $\text{NO}_x$ , HC, and  $\text{NH}_3$ )
- ✓ Data acquisition system for recording of emissions and engine parameter data
- ✓ Global Positioning System (GPS) for measurement of road grades

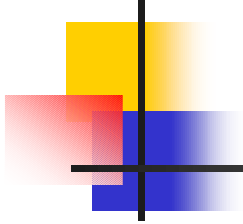


# Light-Duty Vehicle

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- ✓ Work completed
  - ✓ **Characterization of ammonia emissions**
  - ✓ **Comparison with remote sensing measurements**
  - ✓ **Development and testing of protocols for grade data collection with GPS**
- ✓ Work planned
  - ✓ **Additional ammonia emissions tests**
  - ✓ **Toxics emissions tests (1,3-butadiene)**
  - ✓ **Complete grade data collection for RTP-area major roads**





# Remote Sensing

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- ✓ 1997 summertime fleet characterization for MEASURE-RTP
  - ✓ **Data collected for 19 sites**
  - ✓ **Cross-referenced to vehicle registration data**
  - ✓ **Determine vehicle emitter distributions**
  - ✓ **MEASURE will relate fleet characteristics to demographics/land use/registrations**



# Remote Sensing

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- ✓ Contributing to Coordinating Research Council study (Project No. E-23)
  - ✓ **For entire study, remote sensing measurements at selected sites in six cities are being collected to identify trends over a 5-year period**
  - ✓ **Information will be used to estimate high exhaust emitter populations**
  - ✓ **We are collecting 20,000+ remote sensing readings annually at freeway entrance ramp location in Raleigh**
  - ✓ **Work will conclude in 2001**



# APPCD Mobile Team Contacts

<b>Name</b>	<b>Subject</b>	<b>E-Mail</b>
<b>Bruce Harris</b>	<b>Heavy-duty on-road vehicle</b>	<b><a href="mailto:harris.bruce@epa.gov">harris.bruce@epa.gov</a></b>
<b>Julian Jones</b>	<b>Remote sensing</b>	<b><a href="mailto:jones.julian@epa.gov">jones.julian@epa.gov</a></b>
<b>Sue Kimbrough</b>	<b>GIS modeling</b>	<b><a href="mailto:kimbrough.sue@epa.gov">kimbrough.sue@epa.gov</a></b>
<b>John Kinsey</b>	<b>Heavy-duty on-road vehicle</b>	<b><a href="mailto:kinsey.john@epa.gov">kinsey.john@epa.gov</a></b>
<b>Chuck Mann</b>	<b>In-house team leader</b>	<b><a href="mailto:mann.chuck@epa.gov">mann.chuck@epa.gov</a></b>
<b>Richard Shores</b>	<b>Light-duty on-road vehicle</b>	<b><a href="mailto:rshores@epa.gov">rshores@epa.gov</a></b>



# Global Climate Change Technology Assessments

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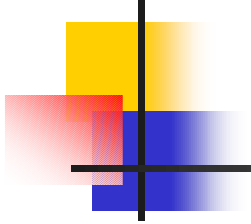
- ✓ Support United States Global Change Research Program
- ✓ NRMRL focus on assessment of impacts of global climate change on air and water quality for energy production and transportation sectors
- ✓ Consequences of global change on tropospheric ozone and particulate matter
- ✓ APPCD contact
  - ✓ **Bob Hendriks (hendriks.bob@epa.gov)**



# Global Climate Change Technology Assessments

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- ✓ Methodology for integrated technology assessments has been developed
- ✓ Focus on personal transportation technologies
- ✓ Address key questions related to technology developments that will affect emissions
- ✓ Need to define technical scenarios for assessments
- ✓ Consider technological changes, socioeconomic factors, adaptations to climate changes



# Transportation Scenarios

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- v **Systematic analysis of how specific alternative fuels and vehicle power systems influence emissions of greenhouse gases, ozone precursors, and particulate matter**
- v **Determine what combinations of fuels and vehicle power systems are likely to penetrate the market in particular timeframes**
- v **Evaluate socioeconomic changes that would influence future decisions about personal transportation and resultant emissions**
- v **Determine how the impacts of such changes can be modeled in global change impact assessments**



# Environmental Technology Verification (ETV) Program

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- ✓ Independent measures to verify performance of innovative technical solutions
- ✓ Accelerate entrance of new technologies into the marketplace
- ✓ Operates through public/private testing partnerships
- ✓ Voluntary for commercially available technologies (is not regulatory or applicable to technologies undergoing research and development)
- ✓ Information at [www.epa.gov/etv](http://www.epa.gov/etv)



# ETV Program

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- ✓ Stakeholder advisory committee has regular meetings (last on 3/8/2001)
- ✓ Generic test protocol for retrofit air pollution control technologies for diesel engines being developed by technical panel (Anticipated May 2001 completion)
- ✓ Technology verification center performs tests and publishes results
- ✓ EPA OTAQ reviews data submitted by manufacturers/vendors and determines allowable voluntary reduction plan SIP credits

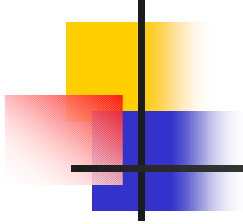




# ETV Program

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- ✓ For mobile sources, focus on heavy-duty diesel engines (highway and non-road)
- ✓ Verification of diesel emission retrofit control technologies for particulate and NO<sub>x</sub>
- ✓ Voluntary retrofit program for State Implementation Plan (SIP) credits
- ✓ APPCD contact
  - ✓ Ted Brna (brna.ted@epa.gov)



# ETV Program

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- ✓ Technology groups
  - ✓ Diesel oxidation catalysts and particulate filters
  - ✓ Selective catalytic reduction for NO<sub>x</sub> control
  - ✓ Fuel-borne catalysts, fuel reformulations and additives, including biodiesel
  - ✓ Lubricants and lubricant additives



# National Exposure Research Laboratory (NERL)

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- ✓ MicroFac model
  - ✓ **Microscale emissions model**
  - ✓ **Needed to estimate real-time emissions to support human exposure studies**
  - ✓ **Developed from MOBILE5/6 data**
  - ✓ **Needs actual traffic fleet data, or can be run using defaults**
  - ✓ **Contact**
    - ✓ Alan Huber ([huber.alan@epa.gov](mailto:huber.alan@epa.gov))
  - ✓ **Also on OTAQ New Generation Model workgroup**



# National Exposure Research Laboratory (NERL)

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- ✓ Emissions processors within MODELS-3 framework
  - ✓ **Community Multi-scale Air Quality (CMAQ) modeling system**
  - ✓ **Includes Emissions Modeling System**
  - ✓ **Processes emissions inventory data to achieve spatial and temporal resolution**
  - ✓ **Sparse Matrix Operator Kernel Emission (SMOKE) system adaptation to framework processes county and link VMT data and calls MOBILE5b for emission factors**
  - ✓ **Bill Benjey (benjey@hpcc.epa.gov)**



# National Exposure Research Laboratory (NERL)

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- ✓ Source apportionment & characterization
  - ✓ Ethanol fuel blend studies
  - ✓ Mobile source fingerprinting in California
  - ✓ Contact: Peter Gabele  
(gabele.peter@epa.gov)